

# **Abstract Book**

## **The 14<sup>th</sup> UK and Ireland Occupational and Environmental Epidemiology Society Meeting**

**3<sup>rd</sup> and 4<sup>th</sup> of June 2021**

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## **Keynote Addresses**

### **Thursday 3<sup>rd</sup> June**

**Professor Paul Wilkinson**  
**London School of Hygiene & Tropical Medicine**

#### **Air pollution and asthma: the 2019/2020 UK inquest into the death of Ella Kissi-Debrah**

In 2019-2020, an inquest was held into the death at the age of nine years of a girl, Ella Adoo Kissi-Debrah, who lived in south London near the South Circular Road. The inquest recorded that Ella had 'severe, hypersecretory asthma causing episodes of respiratory and cardiac arrest and requiring frequent emergency hospital admissions. On 15 February 2013 she had a further asthmatic episode at home and was taken to University Hospital Lewisham where she suffered a cardiac arrest from which she could not be resuscitated.'

The inquest focused primarily on the role of air pollution in Ella's death and concluded that air pollution had been a 'significant contributory factor to both the induction and exacerbations of her asthma' and that she had been 'exposed to levels of Nitrogen Dioxide and Particulate Matter in excess of World Health Organization Guidelines.' The Record of Inquest also noted a 'recognized failure to reduce the level of NO<sub>2</sub> to within the limits set by EU and domestic law' and that Ella's mother had not been given information about the potential role of air pollution in Ella's condition. Had she received such information, the Record of Inquest concluded, 'she would have taken steps which might have prevented Ella's death.'

The inquest raises questions about epidemiological research on air pollution and health and for actions by public authorities, health professionals and the public that respond to the evidence such research generates. These questions will be discussed with reference to the findings of the inquest into Ella's death.

### **Friday 4<sup>th</sup> June**

**Professor Martie Van Tongeren**

**University of Manchester**

#### **Work-related risk of Covid-19, early findings of the PROTECT project**

The PROTECT project is one of the large national core studies funded by the UK Government to address knowledge gaps in risk factors for Transmission of SARS-CoV2. The presentation will provide an overview of the PROTECT study focussing on work-related risk factors, and will include analyses of mortality data and deep-dive in the Public Transport sector.

# Thursday 3<sup>rd</sup> June Session one: General Environmental Epidemiology

## 1. Learning nonlinear effects of environmental exposures with exposure disaggregation regression

**Authors:** [Dr Tim Lucas](#), Dr Fred Piel, Imperial College. Prof. Marta Blangiardo,

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**Keywords:** exposure estimation, temporal mismatch, Bayesian statistics

**Background:** It is common for researchers to use environmental measurements (such as air pollution) at the location of a persons home to quantify exposure but this ignores human movement and heterogeneity of exposure intensity. In particular, this approach can not learn about nonlinear relationships between exposure intensity and disease risk.

**Objectives:** In this work I aim to develop exposure disaggregation regression models that account for the accumulation of short-term risk and can therefore learn nonlinear relationships between exposure and disease occurrence.

**Methods:** I use high resolution estimated air pollution exposures and simulate linear and nonlinear relationships between these covariates and Bernoulli disease occurrences. I then compare the ability of three models to recover the parameters describing the simulated relationships. I use two baseline models (using pollution at the home location and summed exposure) and contrast them to the newly developed exposure disaggregation regression that explicitly models the aggregation of risk. I consider linear effects and nonlinear effects of air pollution modelled using a spline. The models are fitted in a Bayesian framework and estimated posteriors are compared to the known, simulated, parameters.

**Results:** In the presence of nonlinear effects of air pollution on health, both baseline models give biased estimates while the full exposure disaggregation model yields unbiased posteriors. The baseline model that uses the high resolution data to precompute a summed daily exposure tends to overpredict the effect of low levels of air pollution and underpredict the effect of high level exposure.

**Conclusions:** My simulations indicate that fitting standard models can cause directional bias in estimated relationships between air pollution and disease while exposure disaggregation regression models do not suffer from these biases. These models have the potential to be used in a wide range of applications where high resolution covariates are available.

## 2. Which groups of individuals are more likely to die from unintentional carbon monoxide poisoning? An overview of coroners' findings

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**Background:** Knowledge of the circumstances under which unintentional carbon monoxide (CO)-related deaths occur may inform prevention initiatives.

**Methods:** Coroners' narrative reports concerning fatal unintentional non-fire related-CO poisoning, England and Wales, 1998-2018 (includes workplace deaths) were collated by the Office for National Statistics (ONS). We analysed the extracted data by year of death registration, gender, age, national statistics for socioeconomic classification, index of multiple deprivation (IMD), place of death, and source of CO.

**Results:** There were 751 deaths (74 % male). Annual numbers of deaths decreased over the study period (1998: 54 deaths, 2018: 17 deaths). Some two-thirds (68%) of deaths occurred in the autumn/winter. Deaths were highest among all those in semi-routine/routine (32%) and lower supervisory/technical (21%) occupation classifications and in groups with IMD score of 4-5 were 51%. Almost half (45%) of deaths occurred in people's homes (68% male). Males predominated in deaths in vehicles (89%) and in garages (93%). Incomplete combustion of domestic gas was the most common source of CO (23% of all deaths), followed by petrol/diesel (15%) and solid/multifuel fuel (13%). In 40% of cases that involved domestic gas, the appliance involved was a central heating boiler. Most deaths in vehicles (89%) and garages (93%) were of males. A quarter of all deaths (90% male) occurred in boats, tents, garages, workshops, and outhouses.

**Conclusion:** Prevention campaigns should aim to raise awareness of the hazards that may be posed by CO in an enclosed space. Fitting CO alarms and ensuring adequate ventilation in such areas as garages and outhouses may help further reduce unintentional CO-related deaths. Other targeted messages should be in areas with greater deprivation indexes, highlighting awareness in colder months and the danger of using appliances such as barbecues and paraffin heaters indoors.

### 3. Association of household cooking behaviour and acute respiratory infection risk in young children: an analysis of 30 Sub-Saharan African countries

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**Keywords:** Household air pollution, acute respiratory infection, outdoor cooking

**Background:** Acute Respiratory Infections (ARI) are the leading global cause of mortality in children under five years. Cooking location has been shown to influence the level of exposure to household air pollution (HAP) from solid biomass cooking, but there remains a paucity of evidence of the impact of household stove location upon reduction of ARI risk.

**Objectives:** To investigate the (i) contextual and household determinants of stove location, and; (ii) ARI risk among children aged under five years using cross-sectional Sub-Saharan Africa (SSA) Demographic and Health Survey data.

**Methods:** Data was obtained for 278,668 children residing in 30 SSA countries. The outcome variables were composite measures of maternally-reported respiratory symptoms occurring within two weeks of the interview. Multilevel logistic regression, adjusting for country, regional, household and individual-level confounding factors was applied to determine the association between stove location and risk of ARI (shortness of breath, cough) or severe ARI (SARI- shortness of breath, cough, fever).

**Result:** Dry season, rural residence, lower female empowerment, cooking fuel type, smaller households, lower educated, younger household heads and lower household wealth index were identified as determinants of stove location. Children residing in households with outdoor stoves were observed to have lower odds of SARI (AOR:0.85[0.82-0.91]), ARI (AOR:0.87[0.83-0.91]), cough (AOR:0.85[0.82-0.89]), shortness of breath (AOR:0.89[0.84-0.93]) and fever (AOR:0.81[0.79-0.84]) compared to indoor cooking locations. In rural areas only, fever (AOR:0.91[0.87-0.95]) was associated with outdoor stove location compared to indoor location, as were cough (AOR:0.89[0.82-0.95]), shortness of breath (AOR:0.89[0.82-0.96]), fever (AOR:0.86[0.79-0.92]) and ARI (AOR:0.92[0.87-0.96]) in urban areas.

**Conclusions:** In resource poor settings, mitigating HAP exposure through influencing stove location may reduce the associated respiratory health impacts in children under five years. However, there is a need for further investigation into the enablers and barriers of altering cooking location in LMIC settings.

#### 4. Chemical characterisation of the indoor air environment of residential buildings

**Authors:** Ms Thiphanie Riveron, Dr Rebecca Cordell, Prof Anna Hansell, Prof Salman Siddiqui

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**Keywords:** indoor air, volatile organic compounds, residential building

**Introduction:** Nowadays in western societies, the population spends the majority of their time (90%) indoors. This time spent in public and residential buildings can lead to long-term chemical exposure with the potential to impact health. Some volatile organic compounds (VOCs) have been identified as a risk to human health and Public Health England (PHE) have recently published exposure guidelines for eleven VOCs of concern within the indoor environment. This pilot study characterises VOCs present in the home environment and relates them to PHE exposure guidelines.

**Methods:** One litre of air was collected onto sorbent tubes from two private residences at different times of the day, in different rooms and analysed by thermal desorption gas chromatography-mass spectrometry (TD-GC-MS). An indoor air standard was used to confirm identities and quantify a selection of VOCs.

**Results:** This study demonstrated the presence of >300 VOCs per sample, with a predominance of siloxanes (present in personal care products and pharmaceutical products), terpenes (present in household products and fragrances) and hydrocarbons (present in vehicle exhaust), and eight of the PHE VOCs of concern were determined in both environments. The composition of the indoor environment was dynamic with concentrations of some VOCs changing significantly over time. For example, D-limonene had an average concentration of 4.46  $\mu\text{g}/\text{m}^3$  in the morning rising to 67.03  $\mu\text{g}/\text{m}^3$  in the afternoon. The indoor environment varied depending on the home, and the location within the home sampled. For example, benzene had a concentration of 1.37  $\mu\text{g}/\text{m}^3$  in one home but was absent in another.

**Discussion:** This study shows the indoor environment is variable, both spatially and temporally, and this should be considered when designing sampling studies to assess a specific indoor environment and its potential impact on health. Work is ongoing to conduct more measurements and relate exposure to PHE guideline values.

## 5. Impact of the London Ultra Low Emission Zone on health outcomes across the lifecourse: study protocol

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**Keywords:** air pollution; Clean Air Zones; intervention evaluation

**Background:** The London Ultra Low Emission Zone (ULEZ) was introduced in Central London in April 2019. It imposes stringent exhaust emission limits on most vehicle types, including cars. The ULEZ has been predicted to have the potential to bring about substantial reductions in traffic-related air pollution and positive impacts on pollution-related health outcomes.

**Objectives:** This project aims to quantify and evaluate the impact of the introduction of the ULEZ on the health of local residents across the lifecourse, and to determine whether impacts differ across communities by socioeconomic status.

**Methods:** Several health outcomes will be analysed using routinely collected health data. These include birthweight and childhood asthma hospitalisations. An interrupted time-series approach will be used to assess the change in outcome rates before/after the ULEZ introduction, for residents of the ULEZ area. The study period will be 2014-2022. The ULEZ area trend will be adjusted for trends in control areas to address possible time-varying confounding. Control areas will be selected based on comparability of demographics, risk factor trends and non-ULEZ air pollution policies. Cases will be aggregated across the ULEZ area and each control area at monthly or quarterly resolution, depending on numbers of events. The models will also be stratified by socioeconomic status to assess potential differential impacts. Socioeconomic status will be measured using the Index of Multiple Deprivation. The study period is impacted by the effect of the COVID-19 pandemic on traffic, air pollution and hospital admissions. This may be addressed by using similarly affected control areas, limiting the analysis to outcomes less likely to be affected, and modelling the period as a distinct interval.

**Conclusions:** The results will be relevant to policymakers in settings where similar schemes are being considered. They should also contribute to the evidence base on causal links between traffic-related air pollution and health.

## 6. Traffic noise and violent crime: empirical evidence from England

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Chronic traffic noise exposure causes annoyance which could be associated with anger and aggressive behaviour. However, despite the vast research on traffic noise exposure's physical and mental outcomes, little is known about its effect on violent crimes. To explore this question, we compared the number of violent crimes in areas targeted by the second-round noise action plans (adopted by DEFRA in 2014), to that in untargeted areas before and after the intervention in 2012-2017. The noise data and exact locations of areas treated by noise action plans were extracted from the Strategic Noise Mapping database, and crime records were obtained from the Street-level Crime database. We aggregated these data and other control variables at a small neighbourhood level (lower layer super output areas, or LSOAs) for England. The results of the Poisson random-effects models showed a 7.5% reduction in average ambient traffic noise category and 2.86% less violent crime after the intervention compared to untreated areas between 2012-2017. We found no reduction in violence in placebo areas with high traffic noise levels but no relevant noise-reduction interventions. Moreover, we found no evidence of any reduction in non-violent crimes after the interventions. Our results also suggest the presence of a dose-response relationship between traffic noise classes and violence at the LSOA level. Overall, we conclude that traffic noise exposure is likely to lead to violent crime, and the second-round traffic noise action plans on violence have contributed to savings of at least £11 million per year between 2012 and -2017 in England.

## 7. Exploring adaptation to temperature over 20-years in São Paulo, Brazil

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**Keywords:** temperature, adaptation, climate change

**Background:** Temperatures are expected to continue raising compared to what populations are used to. Retrospective assessment of adaptation to such increases is essential to identify policy needs.

**Objectives:** To explore temperature adaptation (2006 vs 2012) for the municipality of São Paulo, Brazil, and to identify differences across population groups.

**Methods:** Daily counts of all non-external causes of death for all the municipality were obtained from the Brazilian Health Department. Daily temperature and humidity measurements were collected from the University of São Paulo weather station, a reference station for the city. I used two indicators to identify adaptation: positive changes in the minimum mortality temperature (MMT) and/or a flattening of the cumulative relative risk (cRR) over time. To evaluate that, I used a time-varying *distributed lag nonlinear model (DLNM)* model, expressed through a linear interaction term between the transformed temperature variable and time. I used 2006 and 2012 as the centring points. To assess differences across groups I stratified the analyses by gender (male vs female), age (below vs above 60 years old), and ethnicity (non-whites vs whites). All models were adjusted for day-of-week, holidays, humidity, seasonality, and long-term trends. Model fit was assessed through qAIC.

**Results:** The MMT increased for all groups, except for non-whites. Females experienced lower cRR for cold yet not heat in 2012, whereas for males, the situation was inverse. The cRR slopes for heat and cold were lower for the <60 years old, while higher cRRs were observed among those ≥60 years old, particularly for temperature extremes. Both the heat and cold cRR slope were slightly lower in 2012 vs 2006 for non-whites. For whites, the cRR was higher for extreme cold and heat in 2012 vs 2006.

**Conclusions:** Our study provides evidence of temperature adaptation and highlights differences across subgroups. This knowledge can be used to inform future targeted interventions.

## 8. Climate change and health equity in UK: systematic review of equity implications of coastal hazards on health and wellbeing

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**Background:** The UK coast is highly vulnerable to climate change due changes to wave height, increased frequency of storm surges, sea level rise and accelerated erosion. Decision makers need information on whether climate change may increase inequalities in coastal communities. Risks to coastal communities from climate change were assessed as part of the UK's Third Climate Change Risk Assessment.

**Objectives:** To systematically review the published evidence on current and future impacts of coastal hazards on health inequalities in the UK.

**Methods:** We developed a search strategy to address all papers that quantified risks associated with coastal hazards. Observational quantitative studies and mapping or modelling studies were included if they used empirical data for a specific location. Coastal community was defined as *any population in a local authority area that adjoins the sea and/or the coastline or impacted by coastal change further upstream.*

**Results:** 4 papers met our criteria. Area-based measures used were standard indices (Multiple Deprivation Index) and novel indicators of "flood disadvantage". There was no evidence regarding other dimensions of inequality. The coastal change exposure was captured in all studies by flood events or flood risk – no study was included reporting on erosion, precipitation, or other coastal change hazards.

**Conclusions:** There are many direct and indirect drivers of coastal change that increase risks to health and wellbeing in coastal communities. Public health inequalities exist in coastal areas and these can be exacerbated by extreme events and coastal climate change, and therefore have implications for coastal risk management. Flood maps can be a poor indicator of risk. Composite indicators of inequality may be less informative if they include inappropriate factors. Overall, there is a lack of evidence on the distributional health impacts from coastal change in the UK, and research is limited by lack of data on robust exposure measures.

## Thursday 3<sup>rd</sup> June Session two: Covid-19 related Environmental Epidemiology

### 1. Exposure to perfluoroalkyl substances and risk for COVID-19, new results and implications for general population exposure

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**Keywords:** PFAS, COVID-19, Ecological

**Background:** Given the pandemic, there is interest in assessing if pollutants affect the risk of COVID-19. There is evidence of immunosuppression by some PFAS (perfluoroalkyl substances) and two recent studies reported associations between PFAS exposure and the risk of, COVID-19 severity or mortality. was study of a population with substantial PFAS exposure from industrial emissions. This paper presents results from the larger study, in Italy (Catelan et al, 2021, Int. J. Environ. Res. Public Health), and considers the relevance to background PFAS exposures such as in the UK.

**Methods:** In part of the Veneto Region, residents were exposed for decades to drinking water contaminated by PFAS (especially PFOA), and mortality was compared in the contaminated “Red Zone” to the rest of the region. A Bayesian ecological regression model with spatially and not spatially structured random components, was fitted to COVID-19 mortality (during Feb-April 2020) at the municipality level. The model included education score, background all-cause mortality (for the years 2015–2019), and an indicator for the Red Zone. The two random components are intended to adjust for potential hidden confounders.

**Results:** From the Bayesian ecological regression model adjusted for education level and baseline all-cause mortality, the rate ratio for the Red Zone was 1.60 (90% Credibility Interval 0.94; 2.51). The study concluded that the higher mortality risk for COVID-19 in a population heavily exposed to PFAS, was explained by chance, PFAS immunosuppression, bioaccumulation in lung tissue, or pre-existing disease being related to PFAS.

**Conclusion:** While these studies need replication, causality is uncertain. However, assuming a linear relationship with exposure, then for a general population with PFAS serum levels at average background levels of exposure the relative risk would be very low but the attributable numbers non-negligible across the whole country.

## 2. Safety CO2 Levels for Indoor Airborne Infection Risk of COVID-19

**Authors:** Xiaowei Lyu, Dr. Zhiwen Luo, Professor Li Shao

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**Keywords:** COVID-19, infection risk, CO2

**Background:** COVID-19, a novel respiratory disease, has caused a worldwide pandemic since the end of 2019. Indoor environment was found to contribute most to the spread of COVID-19. To control infection, most public spaces such as schools, shopping centres and airports were forced to be closed, causing enormous damages of economy. In reopening process, how to efficiently quantify indoor airborne infection risk is one of the most important questions to ask. CO2 is a good indicator for airborne infection risk, as the airborne infectious particles are contained in exhaled breath and CO2 can be a proxy of exhaled breath in places with no other internal CO2 sources except occupants. Safe CO2 levels also refer to CO2 thresholds can be identified, under which a relatively safe indoor environment is ensured. Based on this concept indoor infection risk judgement and monitoring can be achieved by occupants easily without the need for complex risk prediction procedures.

**Objectives:** Our objective is to derive safe CO2 levels for different indoor environments with consideration of various occupancy levels for safe reopening purpose, and assess the uncertainty of the results.

**Methods:** Wells-Riley equation and mass balance equation were used to construct the model for deriving safety CO2 levels. Monte Carlo Simulation approach was applied for uncertainty analysis of estimated CO2 thresholds.

**Results:** The result showed significant differences of safe CO2 levels between different scenarios (such as classroom, open-plan office and subway station). For 50<sup>th</sup> percentiles, the largest value of CO2 thresholds exceeded 1500ppm while the lowest was close to 500ppm. Large uncertainties of CO2 thresholds were also found mainly due to the uncertainty of quanta emission rate.

**Conclusions:** The concept of using CO2 as a proxy for indoor airborne infection risk has been investigated, with CO2 thresholds generated for a range of common indoor scenarios.

### **3. Public Transport during a Pandemic: A rapid review of the literature investigating COVID-19 transmission and control on ground public transport.**

**Authors:** Prof. Sheena Johnson Dr. Nicola Gartland, Prof. David Fishwick, Dr. Anna Coleman, Dr. Karen Davies, Prof. Martie van Tongeren

**Affiliations:** People, Management and Organisational Division, Alliance Manchester Business School, Booth Street West, Manchester, M15 6PB

**Keywords:** COVID-19, public transport, transmission

**Background:** During a pandemic, public transport (PT) is strategically important for keeping the country going, and getting people where they need to be. The essential nature of PT puts into focus the risk of transmission of SARS-CoV-2 in this sector; rapid and diverse work has been done in the past 12 months to attempt to understand how transmission happens in this context and what factors influence risk.

**Objectives:** This review aimed to provide an overview of the currently available literature that assessed the transmission, or potential for transmission, of SARS-CoV-2 on ground-based PT, as well as studies assessing the effectiveness of control measures on PT.

**Methods:** An electronic search was conducted using Web of Science, Ovid, the Cochrane Library, ProQuest, Pubmed, and the WHO global COVID database (latest search March 1<sup>st</sup>, 2021). Exclusion criteria: commentaries, studies regarding the effects of travel restrictions or the effects of COVID-19 on transport habits or industry, population-based studies using transport as a proxy for mobility, air and cruise ship travel, studies not accessible in English.

**Results:** The search strategy identified 26 papers for inclusion in the review; 13 of the studies assessed transmission of SARS-CoV-2, 10 assessed control measures, and five assessed levels of contamination. 11 papers were based on modelling approaches; 15 studies were original studies reporting empirical COVID-19 data. Only two of the papers were based on UK data.

There was evidence for transmission of SARS-CoV-2 on PT, but there were variations in the reporting of the extent of this transmission.

**Conclusions:** The literature is heterogeneous, and there are challenges for measurement of transmission in this setting; while there is evidence for the occurrence of transmission, it is not yet clear what factors contribute to transmission of SARS-CoV-2 on PT. Further exploration of these factors and effectiveness of mitigation strategies is required.

#### **4. Public Transport during a Pandemic: A qualitative study of perceived risk of COVID-19 and risk mitigation on buses and trains.**

**Authors:** [Dr. Anna Coleman](#), Dr. Nicola Gartland, Dr. Karen Davies, Professor Sheena Johnson, Professor David Fishwick, Professor Martie van Tongeren.

**Affiliations:** Division of Population Health, Health Services Research and Primary Care, School of Health Sciences, University of Manchester, Oxford Road, Manchester, M13 9PL

**Keywords:** COVID-19, public transport, transmission

**Background:** The 2020 COVID-19 pandemic created a marked tension for the public transport (PT) sector. UK governments enforced a stay-at-home requirement, whilst PT had to remain open to enable key workers to deliver services during a protracted lockdown. Understanding people's perception of safety in PT during the pandemic could help resolve the legacy of this tension and enable the sector to recover.

**Objectives:** To develop a better understanding of perceptions of risk of SARS-CoV-2 transmission within the PT sector (bus and rail) and effectiveness of risk mitigations to keep both workers and passengers safe.

**Methods:** After initial stakeholder engagement with the PT sector, semi-structured interviews were carried out with experts (research, policy, industry) and organisational representatives (including unions). Individuals were recruited for each of these groups (n=27) and interviews carried out between February and March 2021. Data was analysed using Thematic Network Analysis. Data collection with employees and passengers are planned as part of continuing work.

**Results:** Global, organising and basic themes were identified, and described the experience of changes introduced to the PT sector to reduce transmission of SARS-CoV-2, perceptions of risk mitigation effectiveness, and considerations for how the sector will move forward in the future. Risk of transmission was ascribed predominantly to human factors (rather than transport design), related to number of contacts and employee/passenger adherence to behavioural mitigations.

**Conclusions:** The perceived risk of transmission was generally low, though experts emphasised heightened risk under certain conditions. This is within the context of low passenger numbers which have persisted throughout the pandemic; perceptions of risk should be measured as numbers increase. The deep-dives form part of the wider PROTECT NCS project and will feed into sector-specific evidence synthesis reports. A summary of broad considerations for the optimisation of risk mitigation, aimed at policy makers and industry, will be outlined.

## 5. How has COVID-19 impacted cancer waiting times in England?

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**Keywords:** COVID-19, NHS, public health

**Background:** COVID-19 has been a hugely destructive force in England with almost 3.5mn recorded cases at the time of writing. Due to the huge influx of COVID-19 patients into hospitals, the delivery of cancer services across the country have been severely impacted.

**Objectives:** To investigate performance in the 2WW, 31D and 62D cancer waiting time (CWT) target, before and after the March lockdown (2020) against target operational standards. To examine performance variations in breast, lung, lower gastrointestinal and urological cancers, and variations between English cancer alliances. To investigate changes in the absolute numbers of patients entering these pathways due to the pandemic.

**Methods:** Linear regression was used to assess the number of patients entering CWT pathways. An interrupted time series analysis was performed to test whether CWT target performance decreased after the first lockdown. Heatmaps of CWT performance by cancer alliance were visualised to observe geographical trends. ARIMA modelling was used to model future performance.

**Results:** The 2WW target was the worst affected, due to a sustained decline in breast cancer performance ( $p < 0.001$ ). LGI is the worst performing cancer on the 62D pathway, with performance dropping to an all-time low in April 2020 ( $p < 0.001$ ). This is the only cancer type operating below standard for all CWT measures. Lung cancer performance has remained remarkably resilient. Similarly, urological cancer has not registered any significant negative changes. However, the numbers of patients are yet to really recover to pre-pandemic predicted levels.

**Conclusions:** Considerations should be made to breast and LGI cancer service provision. Reduced target performance indicates fewer patients are receiving the appointments and treatments required. As fewer patients are seen on all CWT pathways than predicted, this corroborates existing findings on the additional unmet need for cancer service provision during the pandemic.

## Friday 4<sup>th</sup> June: Session one: General Occupational Epidemiology

### 1. Quantitative Bias Analysis of the Association between Occupational Radiation Exposure and Ischaemic Heart Disease Mortality in UK Industrial Radiation Workers.

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**Keywords:** radiation; bias assessment; nuclear workers

**Background:** Whether protracted low dose or low dose-rate exposure to external radiation is causally related to circulatory disease risk continues to be an important issue for radiation protection. Previous analyses presented at this conference of a matched case-control nested in a large cohort of UK nuclear fuel cycle workers indicated that there was little evidence that associations between external radiation dose (15-year lagged) and IHD mortality risk (OR= 1.35 (95% CI: 0.99-1.84) could alternatively be explained by confounding from selected lifestyle factors, physiological traits or occupational exposures.

**Objectives:** We conducted quantitative bias analyses to estimate the magnitude and direction of non-random errors, incorporate sensitivity analyses, and simulate bias effects under plausible scenarios.

**Methods:** We conducted quantitative bias analyses of plausible scenarios based on 1,000 MCMC samples to explore the plausible impact of exposure measurement error, missing information on tobacco smoking, unmeasured confounding, or selection (collider) bias.

**Results:** Consistent with the broader epidemiological evidence base, these analyses provided further evidence that the dose-response association between 15-year lagged cumulative external radiation dose and IHD mortality is non-linear in that it has a linear shape plateauing at an excess risk of 43% (95% CI: 7%-92%) around 390 mSv. Missing information on tobacco smoking at start of employment was unlikely to have biased observed associations. An unmeasured confounder would have had to have been highly correlated ( $r_p > 0.60$ ) with cumulative external radiation dose to significantly bias observed associations. The confounding effect of 'having been monitored for internal dose' was unlikely to have been a true confounder in a biological sense. Plausible patterns of exposure measurement error negatively biased associations, but did not importantly change the shape of the observed dose-response associations.

**Conclusions:** These analyses provide additional support for the hypothesis that the observed association between external radiation exposure and IHD mortality may be causal.

**Keywords:** radiation; bias assessment; nuclear workers

## 2. Cohort study assessing the carcinogenicity of styrene

**Authors:** Mr. Will Mueller<sup>1</sup>, Dr. Yvette Christopher-de Vries<sup>1</sup>, Dr. Ioannis Basinas<sup>2</sup>, Ms. Lucy Darnton<sup>3</sup>, Dr. Mette Wulf Christensen<sup>4</sup>, Prof. Martie van Tongeren<sup>2</sup>, Prof. Henrik Kolstad<sup>4</sup>, Prof. Damien McElvenny<sup>1</sup>

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**Keywords:** Styrene; Leukaemia; Lymphoma

**Background:** An analysis of the mortality of around 40,000 workers exposed to styrene in a multicentric cohort study was published in 1994 by the International Agency for Research on Cancer (IARC). It concluded that in the total study population, exposure to styrene was not associated with an excess of mortality from major neoplasms, or specifically from neoplasms of the lymphatic and haematopoietic tissues. However mortality from neoplasms of the lymphatic and haematopoietic tissues increased with time since first exposure and average level of exposure to styrene. A recent re-analysis of the cohort did not substantially alter these original findings. The hazard classification of styrene was upgraded by IARC in 2019 from possibly carcinogenic to probably carcinogenic.

**Objectives:** One of the component studies of the IARC multicentric cohort was a small UK-based cohort study maintained by the Health & Safety Executive (HSE), the follow-up of which has never previously separately been published. We are updating the mortality experience of the cohort without updating occupational histories, and we are extending the follow-up to include cancer incidence for the first time. This update will form part of a wider update to the IARC cohort led by researchers at the University of Aarhus.

**Methods:** We have obtained clearance from an NHS Ethics Committee and the Health Research Authority's Confidentiality Advisory Group. Before receiving mortality and cancer incidence data from NHS Digital, we are in the process of applying for clearance from their Independent Group Advising on the Release of Data (IGARD).

We intend producing SMRs and SIRs for the main causes of interest and, if data allow, to carry out an internal analysis using Cox regression modelling.

**Results:** Not yet available – hopefully by Summer 2021.

**Conclusions:** To be inferred when results are available.

### 3. Progression of long-term conditions and employment in an urban population

**Authors:** Dr Anne Stagg<sup>2</sup>, Dr Sharon Stevelink<sup>2</sup>, Dr Vaughan Parsons<sup>1</sup>, Professor Nicola Fear<sup>3</sup>, Professor Stephani Hatch<sup>2</sup>, Dr Ira Madan<sup>1</sup>

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**Keywords:** long-term conditions; employment; working age

**Background:** The proportion of working-age people with one or more long-term conditions (LTCs) is rising. It is important to understand the risk factors underlying the progression of LTCs and how LTCs impact on employment.

**Objectives:** To determine i) risk factors which predict the development and progression of LTCs in working-age people living in Lambeth and Southwark ii) the associations between LTCs and employment.

**Methods:** South East London Community Health (SELCoH) data from two timepoints 3 years apart in participants aged 16 to 64, were analysed. Differences in the prevalence of LTCs are compared between these 2 timepoints, and how LTCs are distributed across all employment categories. Multinomial logistic regression was used to identify significant associations between socio-demographic, socioeconomic (including employment status), psychosocial and health-related risk factors, and the initial progression from 0 to 1-or-more LTCs, and progression from 1-to-many LTCs. Multinomial logistic regression was also used to investigate the impact of the development and progression of LTCs on employment.

**Results:** Stressful life events and social isolation are risk factors associated with the progression of LTCs. Part-time employment, unemployment and not working due to disability or early retirement were all associated with an increased risk of progressing from one-to-many LTCs compared with full-time employment.

**Conclusions:** Interventions to prevent progression of LTCs should include reduction of social isolation and consider the impact of stressful life events. An important finding was that full-time employment is associated with reduced progression from one-to-many LTCs. Future research should establish what aspects of employment protect against the progression of LTCs.

#### **4. Workplace intervention that aim to improve employee health and wellbeing in male-dominated industries: A systematic review.**

**Authors:** Ms Paige Hulls, Professor, Prof. Frank de Vocht

**Affiliations:** Bristol Medical School, University of Bristol, Oakfield House, BS8 2BN

**Background:** The published evidence on whether workplace health and wellbeing interventions are as effective in male dominated industries compared to mixed-gender environments has not been synthesised.

**Objectives:** We performed a systematic review of workplace interventions aimed at improving employee health and wellbeing in male-dominated industries.

**Methods:** We searched Web of Knowledge, PubMed, MedLine, Cochrane Database and Web of Science for articles describing workplace interventions in male-dominated industries that address employee health and wellbeing. The primary outcome was to determine the effectiveness of the intervention and the process evaluation (intervention delivery and adherence). To assess the quality of evidence, Cochrane Collaboration's Risk of Bias Tools was used. Due to the heterogeneity of reported outcomes, meta-analysis was performed for only some outcomes and a narrative synthesis with albatross plots were presented.

**Results:** After full-text screening, 35 studies met the eligibility criteria. Thirty-two studies delivered the intervention face-to-face, whilst two were delivered via internet and one using postal mail. Intervention adherence ranged from 50-97%, dependent on mode of delivery and industry. 17 studies were considered low risk of bias. Albatross plots indicated some evidence of positive associations, particularly for interventions focusing on musculoskeletal disorders. There was little evidence of intervention effect on BMI, systolic or diastolic blood pressure.

**Conclusion:** Limited to moderate evidence of beneficial effects was found for workplace health and wellbeing interventions conducted within male-dominated industries. Such interventions in the workplace can be effective, despite a different culture in male-dominated compared to mixed industries, but are dependent on delivery, industry and outcome.

## 5. The extent of employee exposure to environmental tobacco smoke in designated smoking areas in the Dublin hospitality industry.

**Authors:** Ms Hannah Byrne, Professor Patrick Goodman

**Affiliations:** TUDublin, TobaccoFree Research Institute, Kevin Street, Dublin 8

**Keywords:** ETS, SHS, occupational

**Background:** Occupational exposure to environmental tobacco smoke is still occurring in the Dublin hospitality industry.

**Objectives:** This study aimed to gather evidence to determine current employee exposure whilst also measuring PM<sub>2.5</sub> concentrations within smoking areas as well as providing insight into possible immediate health effects of ETS exposure.

**Methods:** 75 smoking areas in Dublin hospitality venues were visited from May 2019 – October 2020. PM<sub>2.5</sub> was recorded using a SidePak AM510 Personal Aerosol Monitor inside the smoking area. Contextual variables, including number of employees present and the time spent within the smoking area were recorded during each sampling period. Ten healthy non-smoking volunteers (5 males, 18 – 53 years old, 5 females, 21 – 58 years old) had pulmonary function assessed pre and post exposure to ETS within a smoking area. These tests included exhaled carbon monoxide, forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and peak expiratory flow rate which was also recorded during exposure.

**Results:** Employees noted spending time within 88% of the smoking areas visited. Employees spent >15 minutes in 16% of the smoking areas. Permanent auxiliary bars were present in 21.3% (n=16) of smoking areas. In 23% (n=17) of smoking areas employees were exposed to average PM<sub>2.5</sub> concentrations in the upper quartile (41-189 µg/m<sup>3</sup>). Spirometry results were inconclusive, however, peak expiratory flow rates suggestive of an effect between pre and during exposure ( $p=.051$ ), as well as from pre exposure to post exposure ( $p=.057$ ).

**Conclusions:** Auxiliary bars within smoking areas place employees at risk from ETS exposure in their workplace. Irish legislation should be amended to specifically prohibit the provision of auxiliary bars within exempt areas listed in section 47 of the Public Health (Tobacco) (Amendment) Act, 2004, in order to further protect employees.

## 6. Recall bias in epidemiological studies of pesticide use in the IMPRESS study

**Authors:** Mr Will Mueller, Dr Samuel Fuhrmann, Prof Hans Kromhout, Dr Ioannis Basinas, Ms Kate Jones, Dr Andrew Povey, Ms Hani Mohamed, Prof Martie van Tongeren, Dr Anne-Helen Harding, Dr Karen S. Galea

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**Keywords:** Pesticides, Recall bias, Exposure assessment

**Background:** Epidemiological studies commonly rely on self-reported questionnaire or interview data to assess exposure, so insight in the reliability of such recall is crucial to understand study findings.

**Objectives:** To evaluate farmers and farmworkers' recall of exposure to pesticides and auxiliary information on exposure determinants, and to estimate the size of any recall bias.

**Methods:** We used data from the IMPRESS project, which includes three occupational cohorts of pesticide users in the UK (PIPAH, PUHS, SHAW) and one in Uganda (PESTROP). Workers were surveyed at baseline to ascertain data about the frequency of their pesticide use, PPE practices, and auxiliary information that may affect their exposure to pesticides and were re-assessed 3-17 years later (depending on the cohort). To assess recall, we examined the percentage of overall agreement, sensitivity, specificity, and trends in these measures of agreement by demographic characteristics using regression analysis.

**Results:** Across the four cohorts, n=894 workers provided responses at two time-points. Preliminary analysis identified no overall trends in under or overestimation in hours, days, or years of pesticide application in the Ugandan cohort, but more experienced farmers appeared to underestimate the years working with pesticides (Geometric Mean Ratio [GMR]=0.65 [95% CI: 0.52 to 0.82]). Initial results of the UK PUHS data suggested overall overestimating of years working with pesticides (GMR=1.25 [95% CI: 1.16 to 1.36]). Of 14 pesticides that were reported in the PESTROP cohort, the recalled use at baseline of all but three were overestimated, with lower overall agreement for the most common applied pesticides.

**Conclusions:** Our results to date suggest some evidence of recall bias. We will continue our analysis to examine, for example, the effect on recall of pesticides and PPE use at follow-up and a pooled analysis of the UK data.

# Friday 4<sup>th</sup> June: Session one: Covid-19 related Occupational Epidemiology

## 1. Risk factors for COVID-19 sickness absence in healthcare staff

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**Keywords:** COVID-19, healthcare staff

**Background:** COVID-19 is an occupational hazard in healthcare staff.

**Objective:** We aimed to explore demographic and occupational risk factors for COVID-19 sickness absence during the first wave of the COVID-19 pandemic in England (09-03-2020 to 31-07-2020).

**Methods:** Using data on 959,356 individuals continuously employed by National Health Service (NHS) trusts in England from 01-01-2019 to 31-07-2020, and adjusting for trust, we applied logistic regression to assess odds ratios (ORs) for any or prolonged (lasting >14 days) COVID-19 sickness absence in relation to sex, age, ethnicity, staff group, exposure code (assigned with a job-exposure matrix) and frequency of sickness absence in 2019.

**Results:** The overall cumulative prevalence of COVID-19 sickness absence was 9.7% and that for prolonged absence was 2.2%. In a fully adjusted model with any COVID-19 absence as an outcome, there was no association with sex (OR 1.02 [1.00-1.03]), but risk was lower at older ages (>60 years – OR 0.89 [0.86-0.91]), and higher in non-white ethnic groups (especially Asian – OR 1.65 [1.60-1.70]) and people with more frequent sickness absence for any reason during 2019 (>3 episodes – OR 2.38 [2.32-2.43]). Risk was also higher among people whose work was classed as involving direct care of patients expected to have higher prevalence of COVID-19 than the general population (OR 1.48 [1.40-1.57]), and in several staff groups, including additional clinical services (OR 1.63 [1.55-1.72]), registered nursing and midwifery professionals (OR 1.57 [1.49-1.65]), and allied health professionals (OR 1.33 [1.25-1.41]). Patterns of risk for prolonged sickness absence were broadly similar, except that ORs increased progressively with age rather than falling (>60 years – OR 2.10 [1.98-2.24]) and were even higher for non-white vs. white ethnicity (Asian – OR 2.68 [2.54-2.82]).

**Conclusion:** These findings point to priorities for improved measures to protect against risk of SARS-CoV-2 infection causing COVID-19 absence in healthcare staff.

## 2. Development of a Job Exposure Matrix for work related risk factors for transmission of SARS-CoV-2

**Authors:** Dr. Karin van Veldhoven<sup>1</sup>, Prof. Martie van Tongeren<sup>2</sup>, Dr. Ioannis Basinas<sup>2</sup>, Prof. Alex Burdorf<sup>2</sup>, Dr. Susan Peters<sup>3</sup>, Dr. Luuk van Wel<sup>4</sup>, Dr. Anjoeka Pronk<sup>4</sup>, Dr. Karen Oude Hengel<sup>4</sup>, Prof. Vivi Schlunssen<sup>5</sup>, Prof. Henrik Albert Kolstad<sup>5</sup>, Dr. Zara Ann Stokholm<sup>5</sup>

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**Keywords:** SARS-CoV-2, JEM, occupation

**Background:** Studies have shown a higher mortality due to COVID-19 amongst certain professions (health care workers, cab drivers). The risk of becoming infected with SARS-CoV-2 and the occupational conditions associated with this, have not been studied extensively.

**Objective:** To develop a Job Exposure Matrix (JEM) to assess the risk of COVID-19 in the workplace.

**Methods:** Researchers from three European countries identified six dimensions to classify occupational risk for a typical working day. These include four determinants of transmission risk:

1. Number of adults/adolescents at the same worksite during a typical workday;
2. Contact with adults/adolescents with (suspicion of) COVID-19;
3. Indirect contact with adults/adolescents at work within the same workday;
4. Location of work: inside or outside.

And two mitigation measures:

1. Ability for social distancing among adults/adolescents at the same work floor (patients, members of the public and colleagues);
2. Likelihood of using face covering.

A combination of national statistics and expert judgement was used to classify all ISCO-08 codes (n=492) in no, low, elevated, or high risk for each dimension.

Two aspects of precarious work were included:

1. Job insecurity (proportion of flexible labor contracts);
2. Proportion of migrant workers

These dimensions were data driven, using data from the Labour Force Survey and the Annual Population Survey and classified into: 0%, 1-10%, 11-25%, >25%.

Finally, the JEM was translated to SOC2010 and applied to infection rate data from ONS.

**Results:** The percentage of jobs (SOC2010, n=369) for each score by dimension ranged from 1.4% (high risk dimension 6) to 64.5% (high risk dimension 4). The JEM was validated using % positive data by SOC code from the infection survey, which confirmed an overall increasing risk in each dimension.

**Conclusions:** Successful development of this JEM has resulted in a useful tool for risk assessment of COVID-19 in the workplace.

### 3. Physical distancing threshold in various indoor environments.

**Authors:** Dr Zhiwen Luo<sup>1</sup>, Fan Liu<sup>2</sup>, Prof Hua Qian<sup>2</sup>, Prof Yuguo Li<sup>3</sup>

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**Keywords:** Physical distancing; ventilation; indoor environment

**Background:** Maintaining physical distancing has been considered to be effective at reducing transmission of SARS-CoV-2 virus. The so-called 'social distancing rules' have been implemented in many countries in the on-going pandemic. The US Centers for Disease Control and Prevention (CDC) recommends a 6-foot (2-m) separation, as being seen in Canada, Spain and UK. However, the current 1-2m physical distancing rule is based on the physics of droplet transport and could not directly translate into infection risk. They could vary in different indoor environment due to the change of ventilation system.

**Objectives:** To develop an infection-risk based model to determine the physical distancing in various indoor environments.

**Methods:** We establish a risk-based physical distancing assessment model between the infected and susceptible individuals. Virus-laden droplets are exhaled from an infected person with a viral load. The exhaled droplets then disperse and evaporate in the combined background of the exhaled air and ambient air (air temperature and relative humidity (RH)). Some of the droplets or their residuals (droplet nuclei) in air are inhaled by the exposed person and deposit in the respiratory system, and finally induce infection according to the viral dose-response rate. We consider various indoor environments (in particular with thermal stratification) and relative posture between two standing people.

**Results:** Our results suggest that the one-size-fits-all 2-m physical distancing rule derived from the pure droplet-physics-based model is not applicable under some realistic indoor settings, and may rather increase infection risk. Especially, in a thermally stratified indoor environment, the infection risk could exhibit multiple peaks for a long distance much beyond 2 meters. The relative posture (breathing heights) between two people could also have significant impact on the safety physical distancing threshold.

**Conclusions:** Our study concludes that the physical distancing threshold indoors is impacted significantly by ventilation systems and relative posture between two people.

#### 4. An agent-based model to simulate workplace transmission of COVID-19

**Authors:** Ms Lucy Darnton, [Dr Emma Tan](#), Dr Kevin McNally, Ms Lucy Darnton, Dr Nick Warren

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**Keywords:** COVID-19, workplace, control

**Background:** Understanding how workplace transmission of SARS-CoV-2 is influenced by workplace environmental factors, human behaviour and control strategies is critical. We aimed to develop an agent-based model to simulate how COVID-19 outbreaks propagate within workplaces to investigate the efficacy of potential control strategies.

**Objectives:**

1. Develop an agent-based SIR model for SARS-CoV-2 transmission in relation to daily contact (duration and proximity) between workers.
2. Calibrate model predictions using available empirical data (worker contact networks, evidence on transmission risk and secondary attack rates).
3. Predict the relative efficacy of five types of controls: worker distancing, face coverings, room ventilation, rapid antigen testing and case isolation.

**Methods:** We used the SIR model in which individual workers transition between states in 24-hour steps, and where the risk of individual infection is dependent on contact duration and the infectivity of daily contacts, and on environmental and control factors. Disease characteristics such as the incubation period and daily infectiousness were based on published estimates. Initial development used a published pre-pandemic workplace contact network of French office workers. Individual infection probabilities were based on the Wells-Riley model with parameters calibrated to give SARs (Secondary Attack Rates) consistent with those observed in workplace outbreaks seen via UK Test and Trace. The relative efficacy of different controls was investigated by running the model over different combinations of relevant variations in model parameters and changes to the contact network.

**Results:** Early results confirm that isolation of cases and both close and medium range contact can all have a substantial impact on mean outbreak size, duration and SAR. More detailed results for the five control strategies will be presented.

**Conclusions:** This agent-based model should provide valuable insights into workplace transmission of SARS-CoV-2 as further empirical data on workplace contacts becomes available.

## 5. Environmental SARS-CoV-2 in Scottish hospitals.

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**Keywords:** Covid-19; SARS-CoV-2; occupational exposure

**Background:** Healthcare workers are at high risk of contracting Covid-19 through their work.

**Objectives:** We conducted a field measurement to quantify the levels of virus in air and surfaces and worker activities which may modify their exposure.

**Methods:** We sampled in two Covid positive wards and two non-Covid wards where patients awaited Covid test results in three hospitals in Scotland. Air samples were taken using a Coriolis micro-sampler operating at 200 l/min over 20 minutes. Surfaces were sampled using flocked swabs. Samples were taken from areas around patients, toilets, and elsewhere, then analyzed using reverse transcription polymerase chain reaction (RT – PCR). Contextual data on the sampling locations was recorded (e.g. size, occupancy, ventilation). We observed tasks performed by workers in these wards. We evaluated the duration of each task, surfaces touched, and time spent near patients.

**Results:** We took 127 surface swab and 59 air samples of which 15% had detectable levels of SARS-CoV-2 RNA. Swab samples ranged from <limit of detection (LOD) to 19,200 genomic copies/swab. Air samples ranged from <LOD to 1720 genomic copies per m<sup>3</sup> of air. Room ventilation was generally poorer than recommended in the Scottish Health [Technical Memorandum guidance](#). Virus RNA was only detected in Covid positive wards. Visitor waiting areas in Covid wards had positive samples. Most workers' tasks took less than five minutes, although a few care tasks where the patient was extremely ill lasted well over 10 minutes. About 75% of time in patient rooms was spent within approximately 2 m of the patient.

**Conclusions:** The percentage of samples with detectable levels of SARS-CoV-2 RNA was similar to that of other hospital studies. Ventilation improvements and/or measures to clean air in wards as well as careful cleaning should be applied across all areas, not just patient rooms.